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Multi-channel rivers characterization using Gaussian Mixture Model applied to topobathymetric LiDAR data

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Morphological classifications are often poorly adapted to complexity of rivers. One way of improving them is based on new technologies such as topo-bathymetric LiDAR (LTB). This tool captures a large quantity of data (more than 10 pts.m-2) with a centimetric accuracy. A survey, carried out on the Loire River between Nevers and Nantes (ca. 450 km) allowed to test the potential of the LTB to define morphological signatures in contrasted river sectors (Garcia-Lugo *et al.*, 2015). As a working hypothesis, we propose that the morphology of a river reach on its active width presents a specific morphological signature indexed on elevations and slopes.

Five sites were retained for this work 1) anabranching, 2) sinuous single channel, 3) braided, 4) formerly trained by groynes and 5) trained by groynes.

The morphological signature corresponds to the statistical distribution of dimensionless elevations. Density curves were calculated for elevation and slope data of nondimentionalized detrended Digital Elevation Models. Simplification of complex density curves was reached using a Gaussian Mixture Model to divide the signal. These, simplified signals were compared to corresponding DEMs and correlation was established between statistical signal and spatial data.

Distributions are varying in terms of shape and location on the x-axis. The shape gives an information of lateral connectivity of the system while the location of the curve on the x-axis indicates the predominance of low or high elevations regarding elevation magnitudes. As an example, the description of the anabranching site leads to the identification of the secondary channels network that is also recognized by the GMM. The latter appears to be efficient for identifying the morphological units of a river. For the braided reach, the signature is different from the previous and highlight a system with relative homogeneous elevations . For the site with groynes, the signature clearly highlights 2 morphological disconnected units.

Results of this study are in line with literature concerning both braided and trained rivers (Ashmore *et al.*, 2013 ; Campana *et al.*, 2011). Methodology proposed here allows to identify and assess the meaning of the statistical signal by directly projecting it on a DEM. GMM shows its relative capacity to discretize complex topobathymetrical signal and link it with morphological units. The methodology presented herein is promising for the understanding of river morphodynamics and their classification. It also opens perspectives for river restoration and

management.